Journal of Forestry Research (2013) 24(3): 607–610
DOI 10.1007/s11676-013-0392-3

SHORT COMMUNICATION

Effect of wood chip application on root growth of oak seedling and weed control in northern Iran

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Received: 2012-01-30; Accepted: 2012-05-08

Abstract: It was hypothesized that wood chips can serve as a mulch to improve the growth of young trees by facilitating the development of their root systems, inhibiting weed germination, and suppressing weed growth. The present study was carried out in Ghorogh Nursery, Golestan Northern Iran, in order to investigate the impact of wood chips application on root growth of oak *(Quercus castaneifolia*) seedlings and control of weed. A three centimeter wood chip layer was used on the soil surface as the mulch treatment with bare soil as the control. The number of new roots, the length of exciting roots and the density of weeds were measured after 5 and 12 weeks. Results showed that wood chip application had significant positive effect on the length of excising roots after 5 and 12 weeks compared with control seedlings. Also, weeds were reduced to near zero levels in treated plot. Our findings suggested that wood chip layer on the soil surface in the nursery can conserve soil moisture and prevent nutrient leaching from the rooting zone as well as diminish weed growth which consequently lead to production of high quality seedling.

Key Words: Mulch; root growth*; Quercus castaneifolia*; weed control; Ghorogh Nursery; Golestan Province; Iran

Introduction

A nursery is a place where plants are raised with special care until they are ready or large enough for transplanting into the field (Munjuga 2006). The purpose of a nursery is to produce good quality trees seedlings which are healthy, uniform, and capable of quick field establishment (Munjuga 2006). Forest nursery managers are aware of the significance of weed losses in Iranian nurseries. Weeds directly affect the quantity and quality of forest seedlings and can indirectly cause losses by reducing the length of roots and shoots and thus reduce field survival. Since control of nursery weed is necessary. Weeding is one of the tasks necessary in the nursery. Weeding is usually done 5-6 times to eliminate weeds in the nursery by workers. If you use an herbicide, seedling can be destroying due to the sensitivity of the seedling in the nursery. Seedling preservation of physical injury caused by weeding on one hand, high labor cost and free use of wood residual from the sawmill industry in Iran on the other hand, are the economical reasons for using wood chip in weed control. Application of organic mulch is one effective way to improve the soil condition for root growth and weed control (Iles 2001; Takeda et al. 2005; Strahan 2007; Igbokve 2007). Wood chips encourage root development and suppress weed via improving soil moisture and temperature, shading and also adding valuable organic matter to the soil (Iles 2001; Percival and Evangelos 2006; Wilen et al. 2011). The active organic molecules have been shown to enhance the growth of seedling roots through promotion of adventitious roots on several plant species and highly beneficial in the weed control (Blunden and Woods 1969; Finnie and Vanstaden 1985; Pattison 1994; Walsh 1997; Scott Green 2001). Long term investigation showed that mulching with wood chips increased soil moisture, root growth and used to suppress weeds (Herms et al. 2001). Mulches are used in urban forestry (Duryea et al. 1999) and to lesser extent in wild land forestry (Flint and childs 1987; Vincent and Davies 2003; Geyer et al. 2006) in order to inhibit weed germination and suppress weed growth, prevent water loss from the soil by evaporation, and reduce erosion (Lopushinsky and Beebe 1979; Walker and McLaughlin 1989; McDonald and Helgerson 1990; Gupta 1991; Mayhead 1992; Truax and Gagnon 1993; Haywood et al. 1997) which in turn improves plant growth and survival (Greenly and Rakow 1995; Davies 1988; Chaar et al. 2008). The root density of mature little leaf linden, green ash, sugar maple and red maple trees were greater under mulch than in bare soil (Herms et al. 2001). They stated that turf grass compete for nutrients with seedling roots. Competition with turf grass for soil moisture becomes especially problematic for seedlings during drought periods. Conversely, mulches are commonly used to suppress weeds.

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Corresponding editor: Hu Yanbo

Herms et al (2001) claimed that 3 centimeter of mulch application promoted more root growth and suppressed almost all weed growth on white pine and pin oak saplings. Several studies have found that use of herbicides for weed control kill many species of seedlings (Turner and Loader 1980; Callan 1980; Kuhns 1982; Cooper 1984; Meakin and Orpin 1984; South 1986; Mason and Williamson 1988) hence weed control based on wood chips as a cheap, available, nontoxic and environmentally safe material is good substitute. Also another benefit of wood chips is reducing drought-related transplant shock due to increase of root growth potential in seedling. This investigation aimed to evaluate the influence of 3 centimeter wood chips layer on root growth of *Quercus castaneifolia* and the control of weed in the Ghorogh nursery.

Materials and methods

Study area

Ghorogh nursery is located on the Gorgan-Gonbad highway, 22 kilometers east of Gorgan. The climate is temperate due to its proximity to the Caspian Sea. The annual rainfall is 432 mm. It was established in 1974 for production of high quality seedlings and great customer service. The elevation is 120 m above sea level. The soil texture was a loam. Weeds were controlled chemically using glyphosate (Roundup) prior to planting and taking out by hand during the trial. Average rainfall, relative humidity and temperature during the experiment in the study area were, respectively, 30 mm, 62% and 28°C.

Plant material and experimental design

Seeds of *Quercus castaneifolia* were planted by hand at the Ghorogh nursery at 2 cm square spacing on 20 February 2011. On 21 June 2011, 3 centimeter wood chips were used to cover the soil surface surrounding the three-months-old seedlings in the experimental plot. Two treatments (one mulch plus bare soil only control), three individual replications per treatment, and two sampling dates (2×3×2= 12 seedling per trial) were randomized within the block. The trials were laid out in a completely randomized design. The block was planned in a square formation to minimize effects of any gradients in soil conditions. Three blocks were used and plots were approximately 3 m long and 1 m wide. Effects of wood chips on the root length and root dry weight increment were recorded at 4^{th} and 12^{th} week (at the end of growing season). Watering with equal volumes and frequency with water served as the control and no fertilizers were applied during the experiment. Plots were hand-weeded as necessary during the summer of 2011, and number of weeds was counted. Randomly selected square meter block from each plot were taken for weed counts.

Wood chip specification

Origin of the material was produced from the sawmill industry that are derived from harvesting residue of *carpinus betulus* species. Water content of wood chips was 30% and size of it was 40 mm. Chemical content of wood chips included: 48.5% cellulose, 34% hemicellulose and 17.5% lignin. Wood chips contained more bark and wood than leaves.

Statistical analysis

Effects of wood chips on root length, root dry weight and weed control were determined by Factorial design. Duncan's multiple range test was used to compare means at the 99% confidence level.

Results

Significant effect on root length, root dry weight and weed control were recorded with application of the wood chips (p <0.01*)* (Table 1). Also significant increase (p <0.01*)* in root length and root dry weight was recorded at each times, however no significant effect on weed control were found following time. There was no significant interaction between wood chips and time for any attributes (Table 1). The compared means showed that wood chips significantly enhanced root length and root dry weight growth rate. Seedlings with added wood chips had 20% higher relative root growth rates than control seedlings (Fig. 1 and 2). Also the compared mean showed that weed control was significantly greater in wood chips treatment than in control treatment. The density of weed in wood chips treatment was relatively 55% lower than control (Fig. 3).

Table 1. The influence of wood chips applied on dry weight and control of Oak seedling.

Source	df	Mean Square		
		Root length	Root dry weight	Weed density
Wood chips	1	290.08**	58.08**	154.08**
Time	1	7154.08**	6357.20**	4.08NS
Wood chips * Time	1	102.08	14.52 NS	52.08
Error	8	2.58	4.90	2.83
Total	11			

p <0.01 is considered significant. **=Significant differences (p <0.01), NS = No Significant.

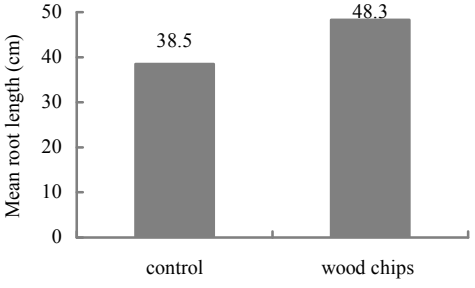

Fig. 1 The effect of wood chips on root length

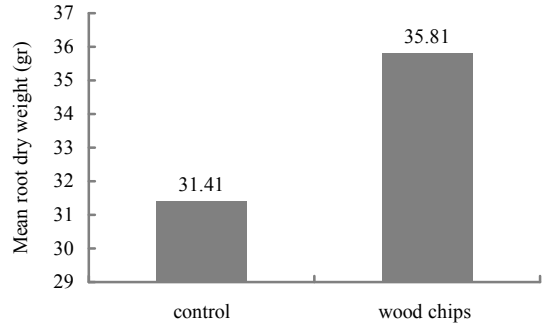

Fig. 2 The effect of wood chips on root dry weight

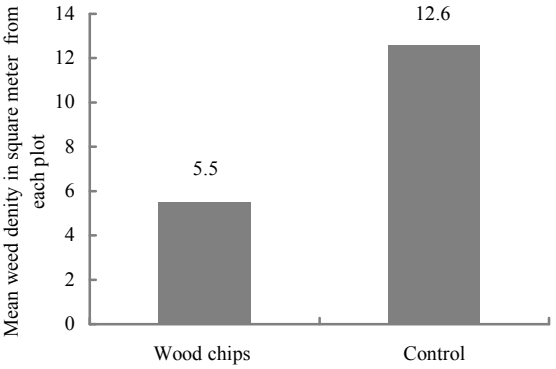

Fig. 3 The effect of wood chips on weed density control

Discussion

Results of this investigation show that application of the wood chips improved root growth of seedlings and weed control following time. Likewise, reduced weed and increased root in wood chips treated indicate applications of wood chips would aid in the survival of seedling following transplanting. Davies (1988) found that the benefit of black poly wood chips was correlated to the patch size of the sheet and he recommended a minimum size of 1 m² for optimal result. Consequently, 1 m wide strips were laid out in this paper. Whitefield (2004) said that in order to maximize the benefits of mulching whilst minimizing its negative influences, it's often applied in late spring/early summer when soil temperatures have risen sufficiently, but soil moisture content is still relatively high that is in agreement with our research. As reported for improving plant growth and survival (Davies 1988; Greenly and Rakow 1995; Chaar et al. 2008) mulches were used. Improved root vigor, as assessed by root growth potential values at week 12, in seedlings supplemented with mulch indicate that mulches were used as direct substrates for root growth (Percival and Evangelos 2006). Biologically active organic molecules such as mulch, when laid out to soils, have been shown to induce changes in the naturally occurring soil rhizosphere populations resulting in alterations to plant nutrient uptake patterns (Pattison 1994; Walsh 1997). Such changes may also have contributed to improved growth in this investigation (Blunden and Woods 1969; Finnie and Vanstaden 1985). Rapid root regeneration is associated with successful transplant establishment. Increase in the root growth potential recorded by week 5 indicates short-term stimulatory effects of wood chips on root regeneration. Consequently, the higher root growth potential values associated with wood chips applied to Oak seedling may reduce drought-related transplant shock symptoms permitting increased root recorded at 12th week. Result of this investigation indicated effects of wood chips on root length, 3 centimeter wood chips is optimal for root formation and lay out soil possibly resulted inducing elongation of existing roots that is in agreement with the findings of Herms et al (2001). The use of mulch in weed-infested areas that border production fields may also help to reduce the rate of reintroduction of these weed into seedbeds. The 3-cm deep wood chip treatment was effective in suppressing weed (Fig. 3) and the results from the study showed that good weed control was possible with wood chips. This study also demonstrates that wood chips controlled weeds and were not detrimental to Oak seedling. Takeda et al (2005) showed that mulch was more effective than bio-weed in controlling weeds and provide a level of suppression achieved during the establishment year. Their work demonstrates that mulch can be applied to suppress weed that with regard to the finding and researches of (Haywood et al. 1997; Scott Green et al. 2001). Our findings clearly showed the importance of weed control with wood chips and are in line with the results of studies investigating the effects of wood chips on weed control (Herms et al. 2001; Takeda et al. 2005; Igbokve 2007; Strahan 2007; Wilen et al. 2011).

Conclusion

Result of our research and that of others show that the use of wood chips can provide many beneficial effects. Wood chips effects on root zone, as well as any potential benefits or consequence for plants such as control of weed, will vary considerably depending on factors such as properties of the mulch, soil type, soil moisture, plant species or cultivar, and weather pattern. By encouraging root growth and conserving moisture, mulching can lessen plant stress in drought-prone environments such as the Iran. Therefore, mulched trees and shrubs are likely to be less drought-prone than their un-mulched counterparts. In nursery, the most common method of weeding is the hand weeding because of closeness of seedling and their delicate nature and physical weeding often damages the young roots and shoots. Therefore, it becomes necessary to make use of mulch for the control of weeds in the nursery. Such benefits have a positive impact not only for those involved in the care and maintenance of urban trees but agricultural, forestry and orchard. Importantly use of wood chips requires no capital investment and only small adjustments to standard management aftercare procedures. In conclusion, applications of wood chips improved root growth and reduced transplant losses in Oak seedling. One aspect of our

finding suggested that root growth of Oak seedling can be improved when wood chips are applied after seedling emerge from seed and another aspect of this research was to test the potential usefulness of new weed control techniques in Oak. Nevertheless, further research is required to determine whether applying wood chips to root system of other tree species would induce similar beneficial responses and further studies are required to understand the mechanistic basic by which this occurred and to determine whether wood chips can provide useful soil amendment for landscape-sized tree greater than 50 mm diameter. This is an area worthy of further research given the fact that wood chips are nontoxic, environmentally safe, and inexpensive to purchase.

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